Regional Wastewater Services Plan

Brightwater Facilities

Addendum to August 23 Report: Brightwater Predesign Cost Estimates

October 2004

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

This information is available in alternative formats upon request by calling 206-684-1280 (voice) or Relay Service 711 (TTY).

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Executive Summary

On June 17, 2004, the King County Council adopted Ordinance 14942, which identified a set of quarterly reporting requirements to provide the Council with the latest cost information for Brightwater. The first report was due on August 23 and required King County's Department of Natural Resources and Parks (DNRP) to provide the following information.

- A phasing analysis and phasing options for the Brightwater project
- The latest cost estimates and impacts on rates and capacity charges
- A value engineering analysis and resulting potential cost savings

King County DNRP submitted a report on August 23 that partially satisfied these requirements. The report presented issues affecting Brightwater costs, a set of preliminary value engineering recommendations, and a phasing analysis.[1] A major conclusion from the phasing analysis is that the Brightwater project could be phased so that the tunnels could provide storage between 2010 and 2012 and the treatment plant could be brought on-line as late as 2012. This could be done without building any new elements into the project other than pumps to empty the tunnels. The flexibility in the Brightwater schedule will be used to respond to delays and optimize bidding to take advantage of market conditions.

At the time the August 23 report was published, the value engineering recommendations were still under review, which delayed the completion of the Brightwater cost estimates. This addendum includes value engineering recommendations and the Brightwater predesign cost estimates, satisfying the reporting requirements for the August 23 report.

The current predesign cost estimate for the Brightwater treatment facilities is about $1.48 billion (2004 dollars). This represents an increase of $133.7 million over the $1.35 billion (2003 dollars) cost estimate presented in November 2003 Final Environmental Impact Statement (Final EIS) estimate. Of this increase, about $127 million, or 95 percent, is primarily attributable to inflation, and in particular to the recent and extraordinary increases in the price of construction materials like concrete and steel. These inflationary premiums have offset King County's otherwise successful efforts to reduce projected costs of the Brightwater wastewater treatment facilities. For example, from 2001 through 2003, King County was able to maintain the cost of this project at $1.35 billion despite ongoing inflation by reducing costs and making design refinements that reduced project costs by about $82 million. King County also made significant cost reductions during predesign in 2004, including savings of approximately $59 million through value engineering. Unfortunately, these efforts could not offset the recent dramatic increase in inflation.

[1] Department of Natural Resources and Parks (2004, August). *Regional Wastewater Services Plan - Brightwater Facilities: Project Status, Value Engineering Analysis, Phasing Analysis*.

Background

This is the fourth cost estimate prepared for the Brightwater project. The first planning level cost estimate, prepared in 2001, was $1.35 billion (2003 dollars). This estimate remained unchanged through 2003 through value engineering and cost stabilization efforts by DNRP and its consultants. For example, the length of conveyance tunnels was reduced from 22 miles to 16 miles, the number of portals was reduced from 10 to 4, and the influent pump station was moved from the plant site to Bothell. These and other refinements effectively offset approximately $82 million of inflation through 2003. In addition, the Brightwater project team also improved the functionality of the facilities and the overall performance of the system during that time by adding value to the design.

- Selecting deep tunneling over cut and cover construction to minimize impacts to the community
- Including a state of the art odor control system
- Designing a membrane bioreactor system to replace the conventional activated sludge to generate high quality effluent
- Developing a high quality, natural stormwater detention system for the treatment plant
- Increasing structural design to meet higher seismic conditions

Predesign Cost Estimates

This addendum presents the detailed cost estimates for the Brightwater project at the completion of predesign, which corresponds to the completion of about 30 percent of the overall project design. During predesign, the design team evaluated more specific and substantial information relating to technology process alternatives, facility size and layout, capacity, hydrology, geology, environment, and cost. This information, along with recommendations from a value engineering review, was reflected in four volumes of detailed drawings and specifications that were used to estimate the cost of constructing Brightwater. Completion of predesign is a major milestone and signifies a much greater level of certainty for the overall project, including cost.

Table 1 summarizes the Brightwater predesign cost estimates as issued in October 2004 and compares the predesign estimates with the cost estimates submitted in November 2003 with the Brightwater Final EIS.

Table 1

Summary of Brightwater Predesign Cost Estimates[a]

Brightwater Component	November 2003 Final EIS Estimate (2003$)	October 2004 Predesign Estimate (2004$)	Difference over/(under)
Treatment Plant	$382.8	$426.5	$43.7
Conveyance System	$754.7	$869.7	$115.0
Mitigation[b]	$88.0	$88.0	$0.0
Land/ROW	$124.0	$98.9	($25.1)
Total	$1,349.5	$1,483.1	$133.7

[a] Costs are in millions of dollars; totals do not add due to rounding

[b] Mitigation does not include odor control costs; they are included in the treatment and conveyance costs.

Table 1 shows that, compared to the Final EIS estimates, Brightwater cost estimates in total have increased by approximately $134 million. The total cost estimate for Brightwater is now $1.483 billion (2004 dollars).

Conditions Contributing to Cost Changes

Inflation is the major factor responsible for the overall cost increase of $133.7 million in the predesign cost estimates. Table 2 shows that inflation accounted for $127 million, or about 95 percent, of the overall cost increase. Of particular significance was the recent and extraordinary increase in the price of construction materials, which accounted for nearly 68 percent of inflation driven factors. For example, major materials that will be used to construct the Brightwater facilities such as reinforcing steel, concrete, ductile iron pipe, and reinforced concrete pipe have increased in price from 6 percent to 42 percent from last year. The effect of inflation is explained in detail later in this addendum.

Table 2

Market Factors Contributing to the Increase in Brightwater Costs

	Treatment Plant	Conveyance System[b]	Total
Inflation (Market Forces)			
Commodity Price Increases	$29.7	$56.7	$86.5
General Inflation (3%)	$10.1	$20.9	$31.0
Labor Premium	$2.5	$5.1	$7.6
Contractor Markups	$12.7	($11.0)	$1.8
Inflation Subtotal	$55.0	$71.7	$126.7

[a] Costs are in millions of dollars (2004 $)

Value engineering and design refinements resulted in a relatively small net increase in construction costs to the Brightwater estimate. For example, the value engineering review identified recommendations that saved approximately $59 million and costs for land were reduced significantly over those presented in the Final EIS estimates. Other design refinements stemming largely from new geotechnical information have added costs to the project. Several other cost savings ideas will be evaluated during design including more phasing options at the treatment plant, implementing an owner-controlled insurance program, using alternative materials to mitigate the affect of commodity pricing, and building a combined tunnel between portals 41 and 44.

Rate and Capacity Charge Impacts

In June 2004, the King County Council approved the 2005 sewer rate and capacity charge for the next two and three years, respectively. The monthly rate was set at $25.60 and the capacity charge was set at $34.05. If the cost estimates and assumptions outlined in this addendum still apply at the time the capacity charges are updated (2008), the baseline capacity charge increase would be between $5 and $7 for 2008. However, by 2006 and 2007 when rates would be set for the following year, the Brightwater project design will have been completed, and initial construction bids will have been received, and many of the costs will be well known. This will allow DNRP to more accurately predict the actual long-term rate and capacity charge impacts.

Next Steps

With the completion of predesign, DNRP and its consultants are moving ahead with final design on the Brightwater project. Final design involves the continued refinement of the project's design so that it complies with recognized standards of safety and performance. The design will then be rendered in a set of explicit drawings and specifications that tell the contractors exactly how to build the facility. Final design will continue through mid-2006 and will include many opportunities to identify additional cost savings for the Brightwater project. During the remainder of 2004 and 2005, we will complete all of the property acquisition and the majority of the permitting. This will also serve to stabilize project costs and provide greater overall certainty in the cost and schedule. In addition, as part of the target setting for the Wastewater Division's productivity initiative, an independent estimator will review the Brightwater cost estimates this winter.

Introduction

This addendum presents the latest cost estimates for construction of the Brightwater Regional Wastewater Treatment System. The following paragraphs describe the purpose and contents of the addendum, including a background discussion about the predesign process and an overview of the factors that have led to the increase in the Brightwater cost estimates.

Purpose and Contents

The purpose of this addendum is to complete a report submitted to the King County Council in August 2004 regarding Brightwater costs and phasing. Two items were needed to complete the report: updated Brightwater cost estimates and the disposition of value engineering (VE) recommendations made in early 2004. The addendum presents cost estimates for both the treatment plant and conveyance components of the system. The estimates are based on completion of predesign of the project. Estimates prepared in November 2003 at the conceptual design phase for the Final EIS are also presented for purposes of comparison.

Cost estimating is complex, time consuming process for a large project such as Brightwater. Engineering assumptions and construction methods change as the project evolves and more detailed information is developed. To help in understanding this complexity and in interpreting the estimates, the addendum provides information on the approach used in the estimating process, including VE, and the factors that had the greatest impacts on costs since the Final EIS estimates were prepared. It concludes with a description of further cost-containment strategies that will be examined and employed through final design and construction of the project.

Background

In November 2003, King County developed cost estimates for the three system alternatives evaluated in the Brightwater Final EIS. These estimates were based on conceptual design of the treatment plant site and conveyance alignment.

King County DNRP began predesign of the Brightwater project in mid-2003. Predesign evaluated more specific and substantial information relating to technology process alternatives, facility size and layout, capacity, hydrology, geology, environment, and cost. Value engineering was an important step midway through predesign. VE is a technical peer review in which outside experts and designers evaluate and develop ideas to improve the project and to lower costs. Preliminary VE recommendations were made in March 2004. Predesign was completed in July 2004, resulting in a set of detailed design drawings incorporating VE recommendations.

King County Council Ordinance 14942, adopted on June 17, 2004, identified a set of quarterly reporting requirements to provide the Council with the latest cost information for Brightwater. The first report was due on August 23, 2004, and required King County's DNRP to provide the following information:

- A phasing analysis and phasing options for the Brightwater project
- The latest cost estimates and impacts on rates and capacity charges
- A value engineering analysis and resulting potential cost savings

In August, King County DNRP submitted a report that partially satisfied these requirements. The report presented issues affecting Brightwater costs, a set of preliminary VE recommendations, and a phasing analysis that described the impacts of deferring the on-line date for the Brightwater Treatment Plant. At the time of publication of the August 23 report, the final VE recommendations were still under review and cost estimates were not yet completed. Accordingly, the King County Executive committed to submit an addendum to Council in fall 2004 that included these elements.

The increasing level of detail presented in the predesign documents provided the information needed to narrow the range of uncertainty and to refine cost estimates. Project elements will continue to be refined as design continues through the 60 percent and final phases. Cost control will remain a high priority as design and construction are implemented.

History of the Brightwater Cost Estimates

This is the fourth cost estimate prepared for the Brightwater project. The first planning level cost estimate, prepared in 2001, was $1.35 billion. This estimate remained unchanged through 2003 through cost stabilization efforts by DNRP and its consultants.

- Reducing the length of conveyance tunnels from 22 miles to 16 miles
- Reducing the number of portals from 10 to 4
- Moving the influent pump station from the treatment plant site to Bothell
- Using a combined tunnel between Bothell and the plant site
- Optimizing the design through informal value engineering

These and other refinements effectively offset approximately $82 million of inflation through 2003. Between 2001 and 2003, the Brightwater project team looked not only at reducing construction costs but also at improving the functionality of the facilities and the overall performance of the system. Better performance could mean an improvement in water quality or a decrease in operation and maintenance costs, a decrease in power consumption, or another measurable benefit to the community. During these years, value was added to the design of both the treatment plant and conveyance system.

- Selecting deep tunneling over cut and cover construction to minimize impacts to the community
- Including a state of the art odor control system
- Designing a membrane bioreactor system to replace the conventional activated sludge to generate high quality effluent
- Developing a high quality, natural stormwater detention system for the treatment plant
- Increasing structural design to meet higher seismic conditions

During predesign in 2004, cost stabilization was further achieved by reducing the amount of land and right-of-way needed, eliminating the tunnel section in Kenmore, performing value engineering that optimized the design, and delaying the cogeneration facility. DNRP is currently evaluating or implementing other ideas to continue to stabilize costs in 2004 and 2005.

- Implementing a productivity program
- Phasing hydraulic capacity in the treatment plant
- Conducting additional value engineering to optimize design
- Building a combined tunnel between Kenmore and Bothell
- Allowing flexibility and incentives in contracting
- Implementing an owner-controlled insurance program

Design Refinements to Offset Inflation

Because inflation is market driven, its effects are difficult to predict and impossible to control through the design process. However, during the years 2001–2003, DNRP was successful in offsetting approximately $82 million of costs due to price increases through changes and refinements to the Brightwater design, as shown in Table 3.

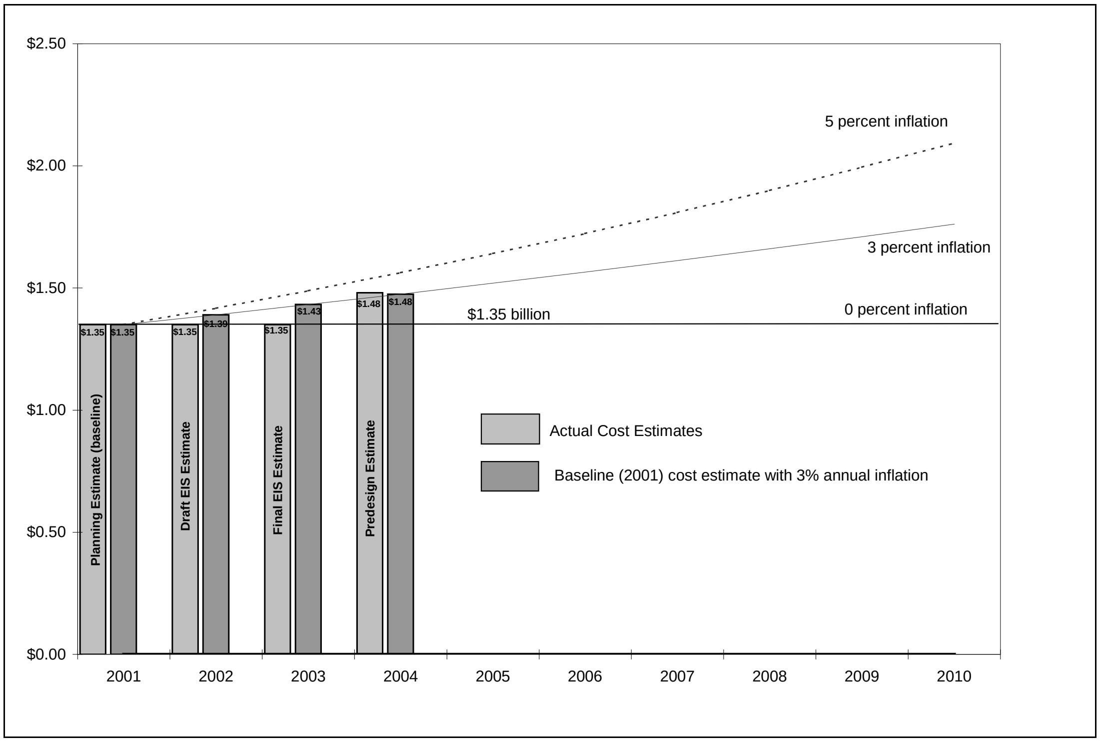
Table 3

Brightwater Cost Estimates and Inflation Trends (millions)

	9/2001 Alternatives Development	11/2002 Draft EIS	11/2003 Final EIS
Cost Estimate	$1,350	$1,350	$1,350
2001 Cost Estimate w/ 3% annual inflation		$1,390	$1,432
3% cumulative inflation added to the 2001 cost estimate	$0	$40	$82

This information is also depicted in Figure 1, which illustrates how the 2001 Brightwater costs (baseline) were maintained below the level of inflation during the years 2002 and 2003. In 2004, the predesign cost estimate was about $134 million above the baseline estimate, largely due to extraordinary premiums on construction materials and labor. However, due to successful cost reduction efforts by DNRP during predesign, the current cost estimate is only slightly higher than the baseline estimate inflated at 3 percent per year.

Figure 1
Inflation Trends and Brightwater Cost Estimates 2001–2004



What's in this Addendum

Following this Introduction, the addendum presents the detailed Brightwater predesign cost estimates, including a discussion of how the estimates were developed and a description of the various components that make up the cost estimates. The next section details the conditions that contributed to cost changes in the Brightwater predesign estimates, both increases and decreases. Overall, it will be shown that uncontrollable market-driven inflation played a significant role in the $134 million increase in costs over those presented in the Final EIS estimate. This section also describes King County's efforts to control costs on the project, including a summary of the value engineering process that took place in the spring of 2004. Finally, this addendum presents a summary of the rate and capacity charge impacts associated with the Brightwater predesign cost estimates.

Predesign Cost Estimates

This section presents the detailed cost estimates for the Brightwater project at the completion of predesign, which corresponds to the completion of about 30 percent of the overall project design. This section begins with a review of the approach used to develop the current cost estimates. It then summarizes the categories that make up the cost estimate and explains the overall impact of each. The section concludes with the detailed (line item) predesign cost estimates for the Brightwater project.

Developing the Estimates

Designing a wastewater treatment system involves a systematic analysis and refinement of options as engineering certainty increases through final design. The design process evolves over a relatively long time, with facilities changing as the design progresses. The estimated cost of facilities can vary at different stages of design. Typically, project costs will increase as engineers become more specific about the size, number, and configuration of project components.

When the RWSP was adopted in 1999, sites for neither the treatment plant or conveyance system had yet been identified. In September 2001, as a set of alternatives were being more specifically defined for the environmental review process, the alternative reflecting the current Brightwater system was estimated to cost approximately $1.35 billion. Cost estimates were also prepared at the conclusion of the Brightwater Draft EIS (November 2002) and the Brightwater Final EIS (November 2003). The project’s physical location and engineering specifications evolved considerably during that time. The estimated cost of the Brightwater system was maintained at $1.35 billion, despite ongoing inflation, through cost control efforts and design refinement.

Value Engineering

Value engineering for the Brightwater treatment plant, conveyance system, and influent pump station took place during and after the preparation of the Final EIS. Value engineering (VE) is a formal process that reviews the “value” of the design usually beginning with the predesign process and repeating at later points in the design process. Value is defined as the efficient design and construction of facilities in relation to the functions that they perform. A VE team looks not only at cost saving opportunities but also at improving the functionality of the facilities and the overall performance of the system. Better performance could mean an improvement in water quality or a decrease in operation and maintenance costs, a decrease in power consumption, or another measurable benefit to the community. The purpose of the VE effort is to present ideas to the design team for consideration and possible incorporation into the facility design. Some ideas will be incorporated immediately, some discarded, and others carried forward for further study as part of final design.

Methodology

Cost estimating involves a narrowing process so as to limit resources and time spent on alternatives that will be discarded during the course of normal design development. Early project cost estimates are done using conceptual estimating methods; as more project details are developed, later estimates employ more accurate deterministic estimating methods. Estimates may involve a combination of conceptual and deterministic methods.

Conceptual Estimating

Conceptual level cost estimates provide a relatively quick method of determining the approximate probable cost of a project without the benefit of detailed design drawings. Conceptual estimates rely on generic facility concepts available in the early planning stages of a project. These concepts are modeled using historical data and algorithms developed for this type of estimating. Conceptual estimating methods are often referred to as “order-of-magnitude” estimates because of their typically wide range of estimate accuracy. Generally, the emphasis with conceptual estimating is not on detailed accuracy but on obtaining a reasonable cost estimate of sufficient accuracy to allow management to make the decisions at hand while providing them with choices about final facilities.

Deterministic Estimating

Detailed estimates use a deterministic estimating methodology in which the independent variables used in the estimating algorithm are more or less a direct measure of the items being estimated, such as straightforward counts or measures of items multiplied by known unit costs. They require a high degree of precision in the determination of quantities, pricing, and the completeness of scope definition and require a substantial amount of time and cost to prepare. It is not unusual for detailed estimates on very large projects to take several weeks to months to prepare and require thousands of engineering hours to prepare the required technical deliverables. As the design proceeds, and more information becomes available on site conditions as reflected in the design drawings, the estimate is refined and greater accuracy is achieved. This concept is illustrated in Figures 2 and 3. Figure 2 shows the degree of certainty about the cost of Brightwater increases as the project continues through the design process. Figure 3 shows the in accuracy ranges for cost estimates that are standard in the industry for large capital projects. The figures illustrate how the accuracy range for cost estimates gets tighter as the design progresses.

Much of the Brightwater predesign estimate is now based on deterministic estimating methods, i.e., they are largely based on unit costs. An important benefit of now having predesign estimates is that DNRP can now more easily and quickly account for factors that influence costs, such as material prices, labor rates, or design refinements.

Figure 2
Certainty of Brightwater Costs

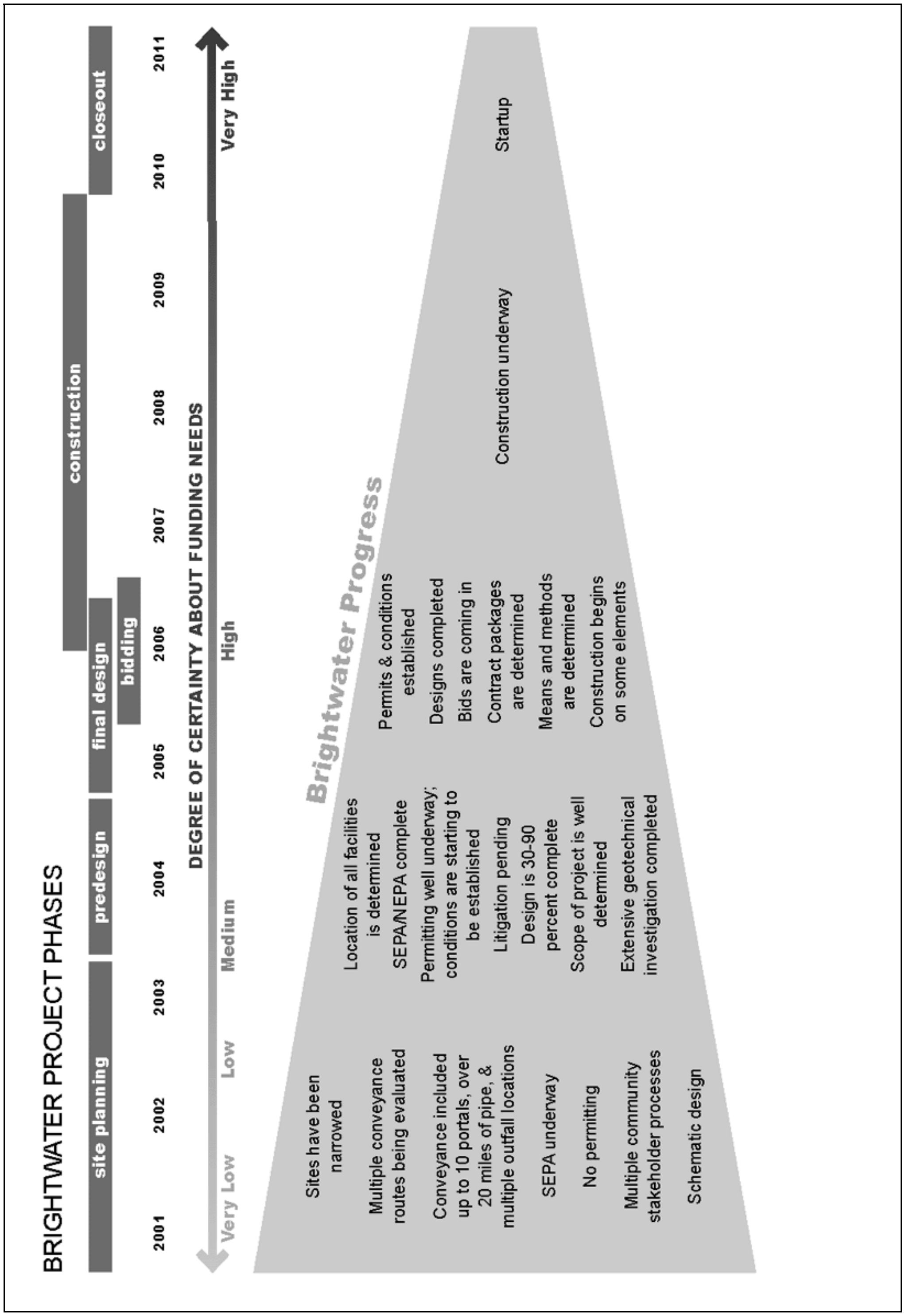
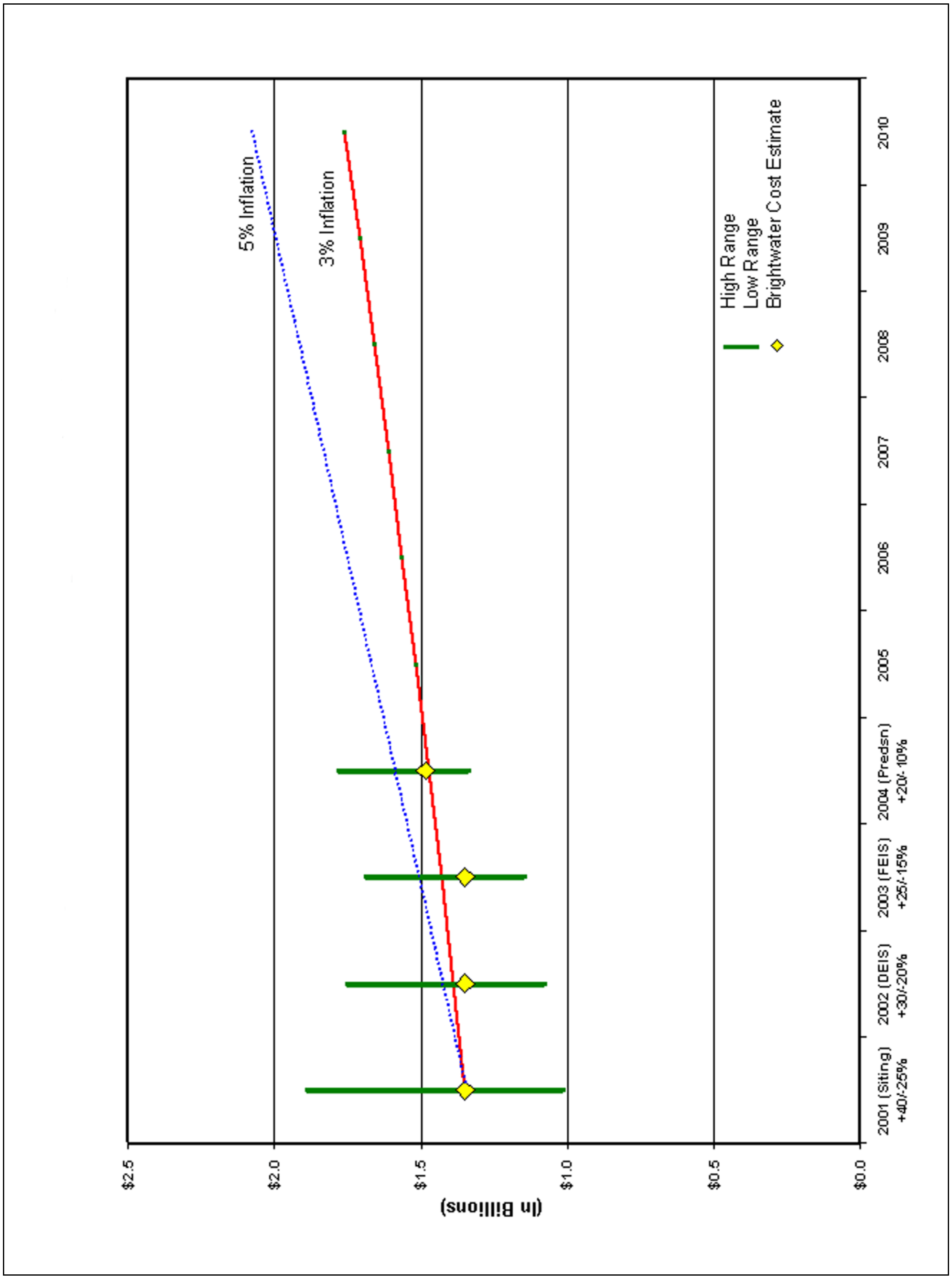


Figure 3
Standard Cost Estimate Accuracy Ranges for Large Capital Projects



Detailed Cost Estimates

Table 4 summarizes the Brightwater predesign cost estimates as issued on October 14, 2004, and compares the current predesign estimates with the cost estimates presented in November 2003 with the Final EIS. The table shows that, compared to the Final EIS estimates, the Brightwater predesign estimates have increased by approximately $134 million, bringing the total cost estimate for Brightwater to $1.483 billion (2004 dollars). The detailed costs for the treatment plant and conveyance system are presented at the end of this section in Table 5.

Table 4

Summary of Brightwater Predesign Cost Estimates (10/15/2004)[a]

Brightwater Component	November 2003 Final EIS Estimate (2003$)	October 2004 Predesign Estimate (2004$)	Difference over/(under)
Construction Costs			
Treatment Plant	$214.5	$259.5	$45.0
Conveyance System	$426.4	$511.9	$85.5
Subtotal	$640.9	$771.4	$130.5
Non-construction Costs[b]			
Treatment Plant	$168.2	$167.0	$(1.2)
Conveyance System	$328.3	$357.8	$29.5
Subtotal	$496.5	$524.8	$28.2
Mitigation[c]	$88.0	$88.0	$0.0
Land/ROW	$124.0	$98.9	($25.1)
Total	$1,349.5	$1,483.1	$133.7

[a] Costs are in millions of dollars

[b] Includes contingency, sales tax, allied costs, art, mitigation, and land/ROW

[c] Mitigation does not include odor control costs; they are included in the treatment and conveyance costs.

For the purpose of explaining the components of the Brightwater cost estimate, the information presented in Table 4 is organized according to the categories of construction costs, non-construction costs, mitigation, and land/right-of way. Each category is summarized below. The specific factors that contributed to the cost changes from the Final EIS estimates are explained in the next section titled Conditions Contributing to Cost Changes.

Construction Costs

Table 4 showed that the construction costs for the Brightwater project have increased about $85.5 million for the conveyance system and about $45 million for the treatment plant. These costs represent an increase of $130.5 million over the Final EIS estimate; however, almost $95 million of this increase is largely attributable to inflation and market driven premiums for construction materials and labor. When the effects of inflation are eliminated, the Brightwater construction costs increased by about $35 million. Inflation and other factors that contributed to the Brightwater cost increases are described in the following section.

Non-construction Costs

The non-construction costs presented in the Brightwater predesign estimate are divided into the following categories: contingency, sales tax, allied costs, and art allowance, each of which is summarized below. Together, the non-construction costs contributed approximately $28 million to the overall cost increase.

Contingency

Contingency is a built in cash reserve to handle unforeseen events in the design and construction of a capital project. The nature of capital projects is that uncertainty is relatively high at the beginning of a project, so the contingency to address this uncertainty needs to be relatively high as well. As more details about the project are known, uncertainty decreases and so can contingency. The Final EIS contingency assumptions will be maintained in the current predesign estimates. Accordingly, contingency costs increased from the Final EIS because the construction costs increased.

Sales Tax

In the cost estimates presented with the Final EIS, the Snohomish County sales tax rate of 8.9 percent was applied to the sum of the base construction cost and construction contingencies for the Brightwater project. The same rate was applied to the conveyance costs in the predesign estimates. However, because the location of the treatment plant is outside of some tax jurisdictions, a reduced tax rate of 7.6 percent was applied to a portion of the treatment plant costs. In addition, the predesign estimate reflects a savings of $1.9 million in sales tax exemptions on costs related to biosolids production and reclaimed water.

Allied Costs

Allied costs are essentially all non-construction costs, excluding land acquisition costs. Examples of these costs include contracts for engineering, professional, and consulting services, miscellaneous materials and services, and staff labor. In the Brightwater Final EIS estimates, DNRP assumed allied costs at 35 percent for the Treatment Plant and 30 percent for conveyance system. The construction allied cost factors were applied to the sum of the base construction cost, construction contingency, and sales tax. Allied costs for land were estimated using a cost factor of 5 percent applied to the base land cost. In the predesign estimate, allied costs were evaluated and capped at the 2003 cost level.

Art Allowance

In the Final EIS, an art allowance of 1 percent was applied to the eligible costs for the treatment plant and conveyance facilities. This resulted in an art allowance of $4.4 million, which has been maintained in the current predesign estimates.

Mitigation

The predesign cost estimates identify $88 million in mitigation funds to pay for measures to reduce impacts related to the construction and operation of Brightwater system, including the treatment plant and conveyance facilities. This amount represents 10 percent of the Brightwater construction costs, including the associated sales tax and allied costs at the time the Draft EIS cost estimates were issued in 2002, per Environmental Mitigation Policy 5 of RWSP Ordinance 13680. A portion of the mitigation budget is committed to specific measures to improve safety and minimize traffic and construction impacts at each Brightwater facility. Examples of committed mitigation include road repaving and widening, traffic caution signals, sidewalks, enhanced landscaping, and noise reduction. The mitigation budget will fund a range of measures that are currently being developed by DNRP in coordination with host jurisdictions, permitting agencies, and tribal governments, as well as in response to public comment. Some potential mitigation ideas expressed to date include habitat preservation, off-site sports fields, open space and trails, sustainable designs, and an education facility and community center. These and other ideas will be presented to host jurisdictions in a draft mitigation proposal for review and comment in December. Their input, along with input from citizens, will help finalize the mitigation plan. It is important to note that DNRP did not include odor control in the $88 million mitigation budget. This represents an additional $48 million in mitigation costs included in the treatment and conveyance cost estimates, bringing the total mitigation allocation to $136 million. As the project progresses an adjustment to the mitigation budget may be needed to meet the environmental mitigation policies.

Land Costs

In the Final EIS estimate, land and right-of-way costs were estimated at approximately $124 million for acquiring the Route 9 treatment plant site, land for the portals, and approximately 400 subsurface easements for the conveyance alignments. As predesign progressed, the conveyance system became better defined. For example, the number of portals was reduced from 10 to 4, the safety relief point was eliminated, and the overall length of tunnels decreased by 6 miles. As a result, only 140 subsurface easements were needed; also, the appraised value of some of the properties and the relocations was less than anticipated. Together, these changes resulted in a savings of approximately $25 million, reducing the land costs in the predesign estimate to about $99 million.

Table 5
Brightwater Treatment Plant Cost Estimates

	FEIS Estimate (2003$)	Predesign Estimate (2004$)	Variance over/(under)
Treatment Plant			
Process Units			
1. Headworks and Truck Loadout Building	$7.9	$12.5	$4.6
2. Grit Removal	$3.4	$9.9	$6.6
3. Primary Clarification	$1.0	$14.5	$13.5
4. Ballasted Sedimentation	$12.5	$0.0	($12.5)
5. Sedimentation Support Building	$0.0	$2.3	$2.3
6. Fine Screen	$2.4	$3.9	$1.5
7. Aeration Basin	$25.3	$33.8	$8.5
8. MBR	$46.1	$47.0	$0.9
9. Solids Building	$21.4	$23.2	$1.8
10. Digester Complex (Building and Digesters)	$22.5	$20.6	($1.9)
11. Water Reuse Disinfection / Reclaimed Water Building	$2.1	$0.0	($2.1)
12. Blending Box/Disinfection	$3.4	$0.1	($3.3)
13. Odor Control	$22.3	$32.1	$9.8
14. Chemical Building	$5.5	$1.8	($3.7)
15a.Storage Building	$0.0	$0.0	($0.0)
15b.Storage/Stockpot Reuse	$0.0	$3.7	$3.7
16. Energy Recovery (Cogen)/Emergency Power	$9.7	$12.6	$2.9
17. Electrical Substation	$5.2	$0.0	$5.2
18. Gallery / Influent Flow Vault	$0.0	$5.6	$5.6
19. General VE Items	($3.9)	($1.3)	$2.6
Subtotals	**$186.7**	**$222.3**	**$35.5**
Site Preparation			
20. Base Hazardous Material Removal	$1.7	$0.4	($1.3)
21. Site Demolition and Prep (Includes Dewatering)	$1.4	$3.8	$2.4
22. Mass Site Excavation	$6.4	$8.6	$2.2
23. Base Backfill	$8.2	$9.2	$1.0
24. Retaining Walls & Slope Stabilization	$0.3	$0.0	($0.3)
25. Permit Stormwater Management	$1.6	$1.6	($0.1)
26. Site Improvements, Underdrains, Yard Piping	$4.5	$3.8	($0.7)
27. Yard Piping	In Process	$8.5	$8.5
Subtotals	**$24.1**	**$35.9**	**$11.7**
Buildings			
28. Administration/Maintenance Building	$3.7	$0.5	($3.2)
29. Administration/Maintenance Building FF&E	$0.0	$0.8	$0.8
Sub-Totals	**$3.7**	**$1.3**	**($2.4)**
Plant Construction Costs Subtotals	**$214.5**	**$259.4**	**$44.9**
Other Costs			
30. Contingency @ 20%	$42.9	$51.9	$9.0
31. Sales Tax (Final EIS @ 8.9%, 30% Design @ 7.6%)	$22.9	$21.8	($1.2)
32. Allied Costs (Final EIS @ 35%, 30% lump sum)	$98.1	$89.1	($9.0)
33. Art Allowance	$4.3	$4.3	($0.0)
Plant Other Costs Subtotals	**$168.2**	**$167.0**	**($1.2)**
Grand Total Treatment Plant	**$382.8**	**$426.5**	**$43.7**
Conveyance System			
Combined Tunnel (Portal 41 to 46)			
Portal 41	$5.8	$8.9	$3.2
IPS Shaft	$10.0	$12.8	$2.8
Portal 46	$1.7	$3.2	$1.5
TBM (41 to 46)	$6.5	$7.5	$1.0
Tunneling and Initial Liner & Second Pass Liner/Pipes	$87.9	$84.0	($3.9)
Portal 46 Below Grade Facilities		$1.0	$1.0

	FEIS Estimate (2003$)	Predesign Estimate (2004$)	Variance over/(under)
Influent/Effluent Tunnel (Portal 44I to 41, Portal 44E to 41, Portal 44E to 5)			
Portal 11	$2.1		($2.1)
TBM (11 to 44I)	$4.3		($4.3)
Tunneling and Initial Liner (11 to 44I)	$18.6		($18.6)
Second Pass Liner (11 to 44I)	$7.3		($7.3)
Portal 11 Below Grade Facilities	$0.7		($0.7)
Portal 11 Above Grade Facilities and Final Site Work	$2.2		($2.2)
Portal 11 Connections	$2.0		($2.0)
Portal 44I		$3.3	$3.3
TBM (44I to 41)		$6.6	$6.6
Tunneling and Initial Liner (44I to 41)	$27.0	$35.7	$8.7
Second Pass Liner (44I to 41)	$10.6	$19.0	$8.5
Kenmore Safety Relief Structure	$1.4	$0	($1.4)
Portal 44I Below Grade Facilities		$0.6	$0.6
Portal 44E	$3.8	$3.6	($0.2)
TBM (44E to 41)	$4.3	$2.8	($1.5)
Tunneling and Initial Liner (44E to 41)	$27.0	$35.1	$8.2
Second Pass Liner (44E to 41)	$10.6	$15.0	$4.4
Portal 5	$3.4	$6.6	$3.2
TBM (44E to 5)	$4.3	$7.4	$3.1
Tunneling and Initial Liner (44E to 5)	$48.0	$59.4	$11.4
Second Pass Liner (44E to5)	$8.2	$15.7	$7.5
Portal 5 above & below grade facilities and final site work	$1.6	$2.1	$0.5
Portal 44E below grade facilities		$0.4	$0.4
Portal 44 Area above grade facilities and final site work	$2.2	$3.1	$0.9
Effluent Tunnel (Portal 19 to 5)			
Portal 19	$1.6	$3.1	$1.5
TBM (19 to 5)	$4.3	$7.4	$3.1
Tunneling and Initial Liner (19 to 5)	$52.3	$65.6	$13.3
Second Pass Liner (19 to 5)	$1.8	$1.6	($0.2)
Portal 19 above & below grade facilities & final site work	$0.6	$6.6	$6.0
Influent Pump Station (Portal 41)			
Influent Structure	$1.0	$2.8	$1.8
Influent Pump Station & Final Site Work	$25.4	$31.8	$6.5
Odor Control Facility	$1.8	$4.6	$2.8
Primary Power	$3.0	$3.6	$0.6
Secondary Power	$3.4	$6.4	$3.0
Microtunnel			
North Creek Microtunnel & N. Creek Connector Facilities	$10.1	$10.3	$0.2
Swamp Creek Cut-&-Cover/Microtunnel	$1.4	$10.2	$8.8
Misc. Hydraulic Controls		$0.3	$0.3
Utility Relocations at Portals	$0.0	$3.5	$3.5
Marine Outfall	$19.4	$20.2	$0.8
Conveyance Construction Costs Subtotals	**$426.4**	**$511.9**	**$85.5**
Other Costs			
Contingency @ 25%	$106.6	$128.0	$21.4
Sales Tax @ 8.9%	$47.4	$57.0	$9.7
Allied Costs (FEIS @ 30%, 30% Design Lump Sum)	$174.1	$172.8	($1.3)
Art Allowance	$0.1	$0.1	$0.0
Conveyance Other Costs Subtotals	**$328.2**	**$357.8**	**$29.6**
Grand Total Conveyance	**$754.6**	**$869.7**	**$115.1**

Treatment Plant Subtotals	**$382.8**	**$426.5**	**$43.7**
Conveyance Subtotals	**$754.6**	**$869.7**	**$115.1**
Land/ROW Costs	**$124.0**	**$98.9**	**($25.1)**
Mitigation Costs	**$88.0**	**$88.0**	**$0.0**
Grand Total	**$1,349.5**	**$1,483.1**	**$133.7**

Conditions Contributing to Cost Changes

This section describes conditions that have led to changes, both plus and minus, to the Brightwater cost estimate that was presented with the Final EIS in November 2003. The section begins with a discussion of two factors that were primarily responsible for the overall cost increase of $133.7 million. The first and most significant factor is inflation; in particular, the recent and extraordinary increase in the price of construction materials. The second factor is the changes and refinements made to the Brightwater design during the predesign process. The section then describes the considerable efforts undertaken by King County DNRP and its consultants to control costs on the Brightwater project. The contribution of each factor to the predesign cost estimates is explained below.

Inflation

Inflation is a market-driven increase in the level of prices over time that reflects the future decrease in purchasing power of today's dollars. Inflation is the single most significant factor contributing to the increase in Brightwater predesign cost estimates, accounting for about 95 percent of the $133.7 million increase. Table 6 shows the majority of inflation is due to premiums on commodities. Each of the components of inflation is summarized below.

Table 6

Market Factors Contributing to the Increase in Brightwater Costs

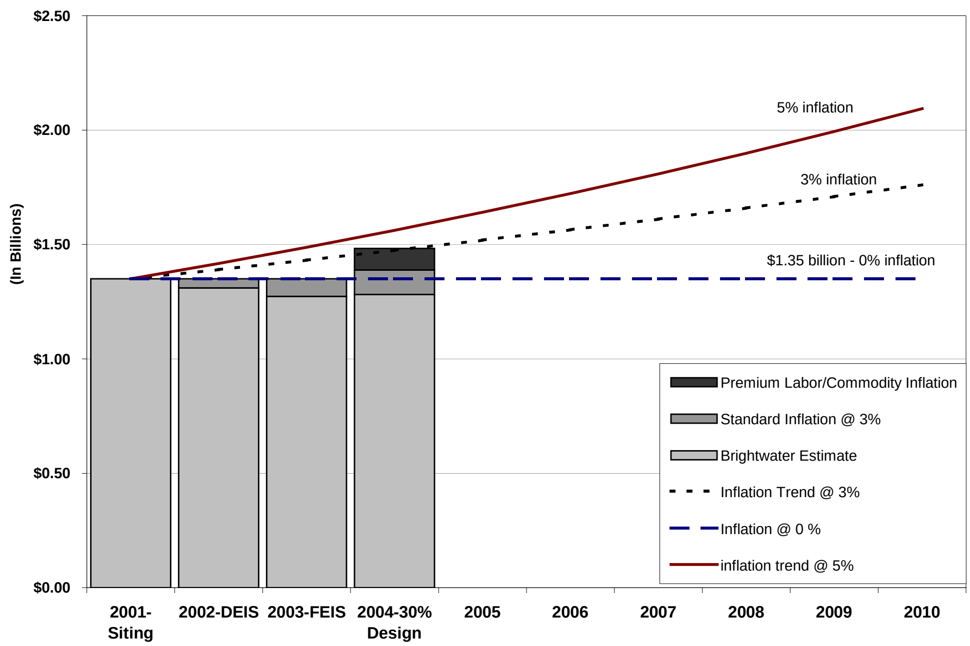
	Treatment Plant	Conveyance System[b]	Total
Inflation (Market Forces)			
Commodity Price Increases	$29.7	$56.7	$86.5
General Inflation (3%)	$10.1	$20.9	$31.0
Labor Premium	$2.5	$5.1	$7.6
Contractor Markups	$12.7	($11.0)	$1.8
Inflation Subtotal	$55.0	$71.7	$126.7

[a] Costs are in millions of dollars (2004 $)

General Inflation

Historically, DNRP has assumed a standard increase of 3 percent per year in estimating costs for its wastewater projects to account for increases in project components such as materials, labor, equipment, or supplies. This rate is also used in commonly accepted indices such the Consumer Price Index. This general inflation accounts for about $31 million of the predesign costs, or about 23 percent of the overall cost increase. However, in the last 12 months, there have been extraordinary increases in prices for commodities (construction materials) and labor that are significantly above the general inflation rate of 3 percent per year. Figure 4 shows the affect of inflation at 3 percent and 5 percent. Given the current economic conditions, 5 percent may better reflect future conditions.

Figure 4
Contribution of Inflation to the Increase in Brightwater Costs



Commodity Premium

Since the beginning of 2004, the construction commodity market has increased to record levels. Construction commodity prices and inflation are being driven by global markets including China, the conflict in Iraq, and hurricane damage in the southeastern United States, all of which have put an unprecedented demand on construction materials. Furthermore, according to the Department of Commerce, public construction is on the rise across the country with the volume of sewage project construction increasing about 8 percent from last year. These demands, when combined with the recent increases in crude oil prices, have resulted in every major construction cost composite index recording inflation at exponential levels, with some recording between three to six times the inflation rate from last year.

The increase in commodity markets began in the first quarter of 2004 when scrap steel price increases drove up the prices of steel construction materials. Through July 2004, structural and reinforcing steel represent some of the largest price increases from last year with structural steel running 23 percent higher and reinforcing steel at

42 percent higher than last year. Reinforcing steel, concrete, ductile iron pipe and reinforced concrete pipe have increased in price from 6 percent to 42 percent from last year and are major materials projected for use with the Brightwater facilities. Table 7 highlights some of the key materials used for the Treatment Plant and Conveyance facilities with their associated annual (12 month) increases from last year.

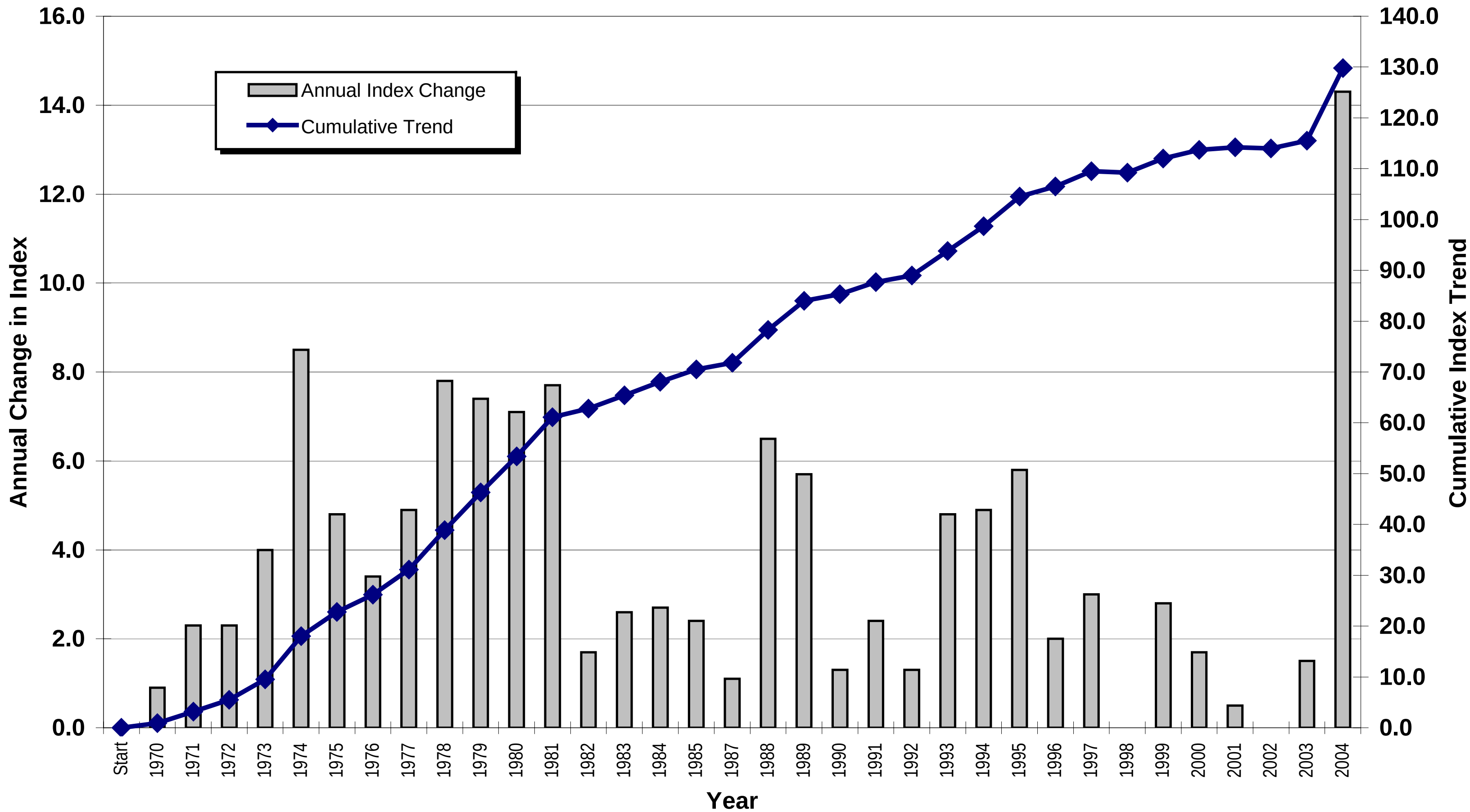
Table 7
Key Specific Material Price Indexes

Material	Annual Increase
Structural Steel	23.3%
Reinforcing Steel	42.1%
Ready Mix Concrete	9.7%
Asphalt Paving	1.5%
Ductile Iron Pipe	14.7%
Reinforced Concrete Pipe	6.3%
PVC Water Pipe	6.0%
Corrugated Steel Pipe	9.2%
Lumber	28.0%
Plywood	25.4%

Source: ENR 20-City Averages July 2003 to July/August 2004

Another indicator of the increase in commodity prices is the Construction Material Producer Price Index. Officially titled the “Materials and Components for Construction,” this composite index is published monthly by the Bureau of Labor Statistics. It measures price changes from the perspective of the seller and is a standard economic indicator for a subset of commodities. Historically, this index has tracked domestic construction material pricing since 1947. Figure 5 represents the mid-year (end of June) indexes for each year to facilitate a direct comparison to the current mid-year 2004 data point since 1970. Notably, the June 2004 annual index increase of 14.3 is the single highest increase in the history of the index. The next highest increase ever recorded was in 1974, which recorded a jump of 8.5. The peak in 1974 was followed by three years of increases, but at reduced levels of between 40 percent and 57 percent of the peak. It is difficult to draw predictions from previous historical trends; however, one trend is consistent from the index since 1947: the index has never adjusted down negatively after a peak year to normalize to the pre-peak inflation level. Accordingly, it is unlikely that the commodity prices will adjust down to 2003 levels.

Figure 5
Construction Material Producer Price Index Trend
Source: Bureau of Labor Statistics



The recent extremes in commodity pricing and labor have severely impacted other public and private entities as well. For example, the Oregon Department of Transportation (DOT) is considering the addition of a clause in their contacts to allow for variances to assist contractors offset the impact of the current volatile nature of material prices,[2] and the Virginia DOT will use a newly written escalation clause in future contracts that will become effective with a price increase of 10 percent.[3] Sound Transit has also rewritten contracts on account of recent increases in steel prices.

Labor Premium

The demand for skilled and common labor has also increased due to the increase in construction, which led to a premium on labor costs. The ENR (20-city average) labor indices for skilled and common labor rose on average 5.3 percent from July 2003 to September 2004, resulting in a $7.6 million, or 5 percent, increase in the Brightwater cost estimates. These national indices were used as an indicator for Brightwater labor costs because if was felt the project would attract national attention from contractors and vendors.

Contractor Markups

Markups are charges added by contractors to their labor, equipment, and materials costs to cover overhead for field or home offices, fees, profit, bonds, insurance or taxes. In estimating construction costs, the first step is to calculate the costs of the direct labor, materials, and equipment needed to perform each task. All other costs incurred by the contractor are referred to as markups.

Two different sets of contractor markups were used in the Final EIS estimates. Contractor markups for the conveyance system were estimated at 28 percent of direct construction costs for the prime (tunneling) contractor and at 25 percent for the subcontractors. Contractor markups for the treatment plant were estimated at about 21 percent of direct costs, which assumed the general contractor would self-perform some of the construction work with no additional markup. Markups are difficult to predict because they are also subject to market forces, though different forces than those that contribute to commodity price increases. Changes in markups due to market conditions are also not well known when most projects are bid as a lump sum.

In the predesign cost estimates, both treatment and conveyance markups were assumed at 25 percent; however, because markups are subject to market conditions they can be very difficult to predict. A 25 percent markup rate reduced conveyance markups by about $11 million and increased treatment plant markups by $12.7 million, resulting in a net increase of $1.7 million in markup costs over the Final EIS estimate. This represents about 1 percent of the overall cost increase.

[2]Bodilly, Lucy (2004, August). *Specialty contractors remain stable despite poor economy.* Retrieved from http://northwest.construction.com/features/archive/0408_Feature1.asp
[3] Korman, Richard (2004, June). *Steel: the art of negotiating price relief.* Retrieved from http://enr.construction.com/features/bizlabor/archives/040628d.asp

Design Refinements

Another factor contributing to an increase in the Brightwater cost estimates is design refinements that result from activities such as value engineering, geotechnical studies, or findings from pilot projects. Refinements are a normal part of the design process and lead to both cost savings and cost increases. Design refinements to Brightwater during the predesign process have led to significant reductions in project scope as well as significant reductions in cost growth, as described later in this section. However, at the completion of predesign, design refinements resulted in a net increase of about $35 million in construction costs to the Brightwater costs estimates. The specific design refinements for both the conveyance system and treatment plant are detailed below.

Conveyance System

The majority of the increase in construction costs was attributable to design refinements in the conveyance system based on additional geotechnical information. In particular, the primary refinement was to decrease the assumption for tunneling productivity from 60 feet per day to 50, as described below. Additional costs were also needed to strengthen the tunnel boring machines due to more abrasive soil conditions than anticipated. A list of the specific design changes by tunnel segment is presented in Table 8.

Tunnel Production Rates

A significant issue on tunneling projects is the rate of advance, or production, of the tunnel boring machine (TBM) under widely differing soil and the groundwater conditions encountered by the TBM. As the amount of geotechnical information has increased during the design process, designers have adjusted the estimated tunnel production rates to reflect this new information. This has been an iterative process in which the geotechnical information is analyzed with the design team and DNRP staff and is then reflected in schedules and cost estimates as appropriate.

In an early review of the conveyance system in September 2001, a review team suggested that the production rate for the Brightwater tunnels could be in the range of 50 feet per shift if reasonably good soils were encountered. With a two-shift operation, this would result in a production rate of 100 feet per day. Since little was known about ground conditions at that time, a larger contingency was included in the estimate to allow for slower progress due to less favorable ground conditions.

In September 2003, a preliminary cost estimate was prepared which assumed an initial tunnel production rate of 76 feet per day. However, as part of the cost review process, an independent consultant reviewed the assumptions and felt that they were aggressive, suggesting instead an average production rate of about 60 feet per day. This lower rate was carried forward in the Final EIS estimate for the initial tunneling and lining for the smaller tunnels. Until midway through 2003, King County had only 50 geotechnical borings for all the conveyance alignments; after the completion of predesign, we had 180 borings on the selected tunnel alignment.

Subsequent to the Final EIS estimate, geotechnical engineers presented additional information to designers regarding high groundwater pressures over significant portions of the tunnel areas as well as areas of very hard clays and gravel. The high groundwater pressures typically slow down tunneling production as the TBM must operate in a pressure mode. With very hard soils, the cutter heads on the TBM wear out quicker and it is necessary to stop tunneling at times to change the cutters. This also slows the average overall production rate. As a result of these conditions, it was recommended that the average production rate for tunneling be reduced to 50 feet per day, which was used in the predesign estimates.

Treatment Plant

The net increase in construction costs is also a result of design refinements at the treatment plant. During predesign, there were significant changes to the treatment plant design such as replacing the ballasted sedimentation process with a chemically enhanced primary clarification process, increasing the number of odor control units, and revising the grit handling process. However, the increased cost associated with these changes was offset by savings in other areas, such as consolidating the site layout and using existing buildings on site for storage, maintenance, and administration. These and other refinements to the treatment plant design are detailed in Table 9.

Table 8

Major Refinements to the Conveyance Design from the Final EIS to Predesign

November 2003 Final EIS Estimate	October 2004 Predesign Estimate
Portal 41 (IPS) to Treatment Plant	
7,600 LF of 21-ft bore tunnel with 4 steel pipes for influent and effluent pipes.	14,100 LF of 17.5-ft bore tunnel with 3 fiberglass reinforced pipes for influent and effluent pipes
7,300 LF of open-cut for 4 steel influent and effluent pipes	None
Microtunnel jackings for fiberglass-reinforced influent and effluent pipes, under SR 522	None
Treatment Plant portal is cylindrical	Treatment Plant portal is rectangular to facilitate higher production rates for pipe installation in tunnel
Portal 41 Site - rectangular sheet pile shoring influent structure and cylindrical slurry wall shoring influent pump station	Portal 41 Site - cylindrical slurry wall shoring influent structure, and double cylinder influent pump station
Influent Pump Station	
N/A	Double cylinder influent pump station increased structure concrete for below grade facility
Generator facility 120-ft x 90-ft	Generator facility 232-ft x 70-ft
Odor control facility 85-ft x 70-ft	Odor control facility 145-ft x 97-ft
Substation facility 120-ft x 130-ft	Substation facilty 150-ft x 120-ft
Minimal final site work	Extensive final site work
Portal 5 (Ballinger Way) and Portal 41 (IPS)	
Portal 44E to Portal 41	
11,729 LF of cast-in-place concrete second liner	7,187 LF of steel pipe second liner & 4,400 LF of cast-in-place second liner
None	Concrete ring wall required for TBM break-in at Portal 44E
Portal 11 to Portal 41	
Tunnel from Portal 11 to 41, by-passing Portal 44	Eliminated Portal 11 to 44 reach for future considerations
3,700 LF of Swamp Creek Interceptor pipe relining	Swamp Creek Interceptor flow diverted to Portal 44I via 700 LF of 42” open-cut pipe and 2,510 LF of deep 72” microtunnel
Portal 44E to Portal 5	
9,110 LF of cast-in-place concrete second liner	5,530 LF of steel pipe second liner & 6,600 LF of cast-in-place concrete second liner
None	Concrete ring wall required for TBM breakout at Portal 44E
Portal 5 with slurry wall construction method	Deeper Portal 5 with a refined construction method of ground freeze with sequential excavation method.
None	Transition details between tunnel an portal structure
None	Integrate TBM steel shell as part of transition structure from tunnel portal 5
Portal 11 to 41, 19,809 LF of fiberglass-reinforced pipe second liner	Portal 44I to 41, 11,592 LF of steel pipe second liner
Portal 19 (Point Wells) to Portal 5 (Ballinger Way)	
Truck haul tunnel spoil	Barge haul tunnel spoil
Shoreline pipe include with Marine Outfall	Shoreline pipe included with Portal 19
Portal 5 at 30-ft OD, and 180’ deep with slurry wall construction	Portal 5 at 42-ft OD, and 202 deep with ground freeze construction
None	Integrate TBM steel shell as part of transition structure from tunnel portal 5.
None	Transition details between tunnel an portal structure
None	Concrete Ring Wall required for TBM break-in at Portal 5
Marine Outfall	
Shoreline pipe include with Marine Outfall	Shoreline pipe included with Portal 19

Table 9

Major Refinements in Treatment Design from the Final EIS to Predesign

November 2003 Final EIS Estimate	October 2004 Predesign Estimate
Process Units	
Headworks: The headworks facility estimated for the Final EIS contained less infrastructure than that for the predesign estimate. The complex included a small chemical room.	Added facilities to support the chemically enhanced primary clarification (CEPC) process and to provide gallery access to the screens.
Grit Removal: The grit removal process changed from vortex in the Final EIS estimate to aerated grit in the predesign estimate as a result of the decision to accept the CEPC process in lieu of ballasted sedimentation.	The aerated grit process is larger than conventional aerated grit to accommodate the chemical flocculation time requirements of the CEPC process.
Primary Clarification: The Final EIS was based on use of conventional sedimentation basins for average flow and ballasted sedimentation for peak flows.	An accepted VE change was to provide CEPC for peak flows in lieu of ballasted sedimentation, which has operational benefits compared to ballasted sedimentation.
Aeration Basin: The layout and size of the aeration basins is approximately the same between the Final EIS and predesign.	The estimate increase resulted from better understanding of the design details (e.g., mechanical complexity, piping quantities, piping sizes and materials of construction, control valves) in the predesign.
Odor Control: The Final EIS had more odor control units, but less support infrastructure than the predesign.	As a result of site compression, which required the odor control to be relocated, ductwork and mechanical equipment increased associated with conveyiing air a greater distance. A building housing the mechanical equipment will prevent noise transmission and provide for better protection and maintenance of equipment.
Storage/Stockpot Reuse: A storage facility was not included in the Final EIS estimate due to budget constraints. It was assumed that storage would occur at other County treatment facilities or would be leased, an operational cost.	Use of Stockpot is being considered to provide cost effective storage. This provides additional functionality compared to the Final EIS estimate and would reduce operational costs associated with leasing off-site storage.
Gallery/Influent Flow Vault: In the Final EIS estimate, all costs (structural, mechanical and electrical) for interconnecting galleries (those portions between process areas) were distributed between the process areas.	The predesign estimate includes a line item which identifies all costs for interconnecting galleries separately. Basement of the headworks building has been extended to include space for influent flow meters which were originally to be located at the influent pumping station. Gallery lengths reduced significantly as a result of site consolidation.
Site Preparation	
Site Demo and Prep: The Final EIS Estimate did not allow for work which, at the time, was expected to be in the Contractors General Conditions Estimate.	The quantity of topsoil that will require removal and stockpiling is higher than estimated at the time of the Final EIS Estimate based on preliminary discussions wiith Hoffman Construction. Estimates for earthmoving and stockpile will be refined as the construction planning proceeds.
Mass Excavation: Final EIS estimate for cement amended native fill and drying of this native fill was relatively small.	The site estimate is currently carrying a sizeable amount of conditioned fill. As this scope of work is refined and geotecchnical studies completed, an opportunity exists to reduce costs if less conditioned fill is required.
Yard Piping: The Final EIS Estimate was performed with very preliminary information on the number, length, and quantity of yard piping.	Further advancement has resulted in significant scope reduction over that shown in the schematic design by eliminating redundant pipes, elimination of lining not deemed to be necessary and rerouting certain large diameter pipes to optimize the layout.
Buildings	
Admin/Maintenance: The Final EIS estimate assumed utilization of the OPUS building for light maintenance and administration	Stockpot is being considered for utilzation as the least cost option for adminstration, maintenance, and storage. Separate facilities are required for main control.

Cost Stabilization Efforts

During the predesign process, DNRP and its consultants made significant savings through value engineering and design refinements. As the Brightwater final design process continues, DNRP will continue to evaluate ideas to reduce costs and the associated rate and capacity charge levels. Each of these cost stabilization efforts are described in more detail as follows.

Value Engineering

Value engineering (VE) for the Brightwater treatment plant, conveyance system, and influent pump station took place late 2003 and early 2004 between preparation of the Final EIS and the predesign cost estimates. During the VE workshops, a multidisciplinary team of experienced engineers reviewed conceptual plans for the project, evaluated the cost of constructed facilities in relation to their proposed functions, and made recommendations. The design teams incorporated many of the VE recommendations into the predesign, either intact or modified to accommodate other design changes. In some cases, VE suggestions were analyzed by the design teams and were not feasible, or could not achieve the projected VE savings. The net savings from VE was approximately $59 million, as detailed in Attachment 1 (Tables 13–15). Overall, the VE recommendations helped contain cost increases for the project as well as improved the quality of the project design.

VE efforts for Brightwater consisted of three separate 40-hour workshops to review conceptual design documents. The workshops took place in December 2003 for the treatment plant, January 2004 for the conveyance system, and March 2004 for the influent pump station (IPS). Each team was comprised of experienced engineers representing multidisciplinary backgrounds who had no involvement in the design.

All three workshops were led by a professional engineer who was also a certified value specialist. The VE leader had conducted hundreds of VE workshops over the past 20 years. Each workshop consisted of the following steps:

- Reviewing the basic functions of each facility
- Brainstorming ideas on alternative ways of performing that function
- Evaluating ideas for their feasibility
- Developing feasible ideas into engineering concepts
- Evaluating the costs of the alternatives

VE team recommendations were developed conceptually and did not represent fully engineered solutions. Following the workshops, the design team developed the VE proposals in more detail, which took about 5 months to complete. The result of the predesign VE process was that some VE recommendations were accepted and incorporated into the design, some were modified and incorporated into the design, and some were rejected. Table 10 shows some of the major VE recommendations incorporated into the design for the treatment plant and conveyance system. The specific VE recommendations are detailed in Attachment 1.

Table 10
Major VE Changes for the Brightwater Facilities

VE Recommendation	Outcome in Predesign
Treatment Plant	
Store diurnal peaks; do not take diurnal peak flows through MBR	Design based on storing diurnal peaks; reduced number of MBR cassettes but not tankage; phased MBR equipment procurement
Defer purchase and installation of standby power	Standby power is not included in the predesign
Eliminate chemical storage building; use covered areas as needed	Chemical building was reconfigured
Cut size of admin. building by 15%	StockPot Building is being considered as the least-cost option for administration, maintenance, and storage
Conveyance System	
Eliminate tunnel from portal 11 to 44 and replace with force mains	Entire segment from Portal 11 to portal 44 was eliminated
Make combined tunnel 16' diameter and use fewer/smaller pipes	Reduced tunnel diameter to 17'6" and eliminated one of the internal pipes

[a] Construction costs

In all, the VE recommendations helped control approximately $59 million in the growth of construction costs during predesign, including $36 million for the treatment plant and $23 million for the conveyance system and influent pump station.

Design Refinements in 2004

DNRP was not able to offset inflation in 2004 as we had done in the prior two years because of the extraordinary inflationary increases described above. However, we were still able to stabilize construction costs in 2004 through a value engineering review and design refinements as explained below.

Treatment plant Design Refinements

During predesign, the design team began to see treatment plant costs increase significantly over those identified in schematic design. To counter these increases, the design team examined all aspects of the design and identified efficiencies and refinements that achieved individual cost savings costs in the range of $100,000 to several million dollars. For example, significant cost saving refinements to the treatment plant design included consolidating the site plan, revising the primary treatment processes, resizing the membrane bioreactor process, and modifying the odor control systems. In terms of the site plan, the Final EIS schematic design presented a relatively open layout for the process facilities. The value engineering team suggested consolidating the site plan to achieve reductions in gallery facilities (throughways for piping and electrical conduit), site work, pumping, and hydraulics. This consolidation will also optimize cut and fill operations.

Another significant refinement was made to the plant's primary treatment systems. Based on VE recommendations, the design team eliminated the proprietary ballasted sedimentation process and revised the conventional primary sedimentation process to operate as chemically enhanced primary clarification (CEPC) to treat peak flows. This change led to the implementation of other refinements, including the addition of two additional conventional primary clarification tanks (seven vs. five) to allow both CEPC and conventional primary treatment, as well as the use of an aerated grit removal system instead of the vortex system. . Collectively, these refinements will improve operation of the facility, eliminate procurement of a proprietary process, which carries significant cost risk, and reduce long-term operations and maintenance costs.

Conveyance System Design Refinements

While the conveyance system experienced a net increase of $33 million in construction costs over the Final EIS estimates, several items identified during predesign helped reduce costs that would otherwise have been much higher. For example, the removal of the tunnel segment between Portals 11 and 44 reduced costs by approximately $37 million. Another significant cost saving resulted from reducing the combined tunnel diameter from 24 feet to 17.5 feet and reducing the number of internal pipes from four (three influent lines and one effluent line) to three (two influent lines and one effluent line). The design team committed to an approach that will establish a minimum size for the pipes that will go into the tunnel and allow the contractor to further reduce the size of the tunnel if performance criteria can be met, which may create additional opportunities for cost savings.

Another significant opportunity to reduce costs can be achieved by using the existing Stock Pot building for plant service functions, allowing a significant reduction of the plant operations building. Further, a careful review was made of various building rooms and plant work sites to classify heating needs more closely by specific work activities, functions, and occupancy, allowing a several million dollar reduction in building insulation.

Options for Further Reducing Cost

As the Brightwater final design process continues, DNRP will continue to evaluate ideas to reduce costs and the associated rate and capacity charge levels. One possibility is to take advantage of flexibility in the existing construction schedule. Brightwater is currently scheduled for completion in 2010, but a recent analysis found that by using storage in the Brightwater conveyance system, the Executive has the flexibility to adjust the Brightwater completion date between 2010 and 2012. This could allow us to take advantage of opportunities to react to market conditions, employ labor efficiently, and smooth cash flows in peak construction years.[4] The Executive will continue with the present schedule to complete Brightwater in the fall of 2010 and use the available flexibility as needed to construct Brightwater as efficiently and cost effectively as possible. Several other cost savings ideas will be evaluated during design including more phasing options at the treatment plant, implementing an owner-controlled insurance program, using alternative materials to mitigate the affect of commodity pricing, and building a combined tunnel between portals 41 and 44.

[4] Department of Natural Resources and Parks (2004, August). *Regional Wastewater Services Plan - Brightwater Facilities: Project Status, Value Engineering Analysis, Phasing Analysis*.

Rate and Capacity Charge Impacts

On June 17, 2004, the King County Council adopted Ordinance 14942, establishing the 2005 sewer rate of $25.60 and capacity charge of $34.05 with the intent of maintaining the sewer rate for the next two years and the capacity charge for three years. The rates and capacity charge associated with the 2005 rate process are shown in Table 11. The intent of maintaining these rates for two and three years is to provide stability for rate payers during a period in which information and cost projections are being refined. With respect to the capacity charge, the adopted level included $70 million in unspecified cost savings through facility phasing, value engineering, and updated information concerning projected facility needs across the entire WTD capital program.

At the end of this stable rate period, the capacity charge will be reevaluated with new information from a comprehensive update to the Regional Wastewater Services Plan and improved estimates for the Brightwater project. The rates and charges adopted by the council are expected to generate adequate revenues for the wastewater capital program over the period for which they were set. The effects of the commodity price increases will be incurred mainly during the project construction period and as such do not affect nearer-term capital expenditures or debt service considerations. Additionally, the uncertainty surrounding the outlook for future commodity price increases makes it premature to propose changes in either rate or capacity charge. Additional time is need to understand the outlook for price changes and to continue our efforts to locate savings before proposing any changes to the rate or capacity charges.

Table 11
Adopted 2005 Capacity Charge and Rates and Projected Rates in the RWSP Financing Plan

Year	Capacity Charge	Monthly Sewer Rate
2005	$34.05	$25.60
2006	$34.05	$25.60
2007	$34.05	$28.55
2008	$36.20	$31.51

Source: Executive's 2005 Budget WTD Financial Plan

In this section, rate and capacity charge estimates incorporating the predesign design cost estimates are compared to those associated with the rate and capacity charge adopted in June of 2004.

Table 12 presents the predesign design costs in the context of the 2005 adopted rate and capacity charge. All scenarios presented assume the $34.05 capacity charge is maintained through 2007 and any changes due to the cost estimates would be reflected in 2008. As stated above, the baseline capacity charge included the assumption that $70 million in program-wide savings would be found during the 2003-30 period

Table 12

Capacity Charge and Rates Associated with predesign Design

Scenario	Capacity Charge		2003 – 2030 Rates	
	2005 – 2007 Capacity Charge[a]	2008 Capacity Charge	2005 – 2006 Sewer Ratea	2003-2030 Levelized Sewer Rate[b]
Baseline	$34.05	$36.20	$25.60	$25.73
Predesign BW 2010	$34.05	$43.25	$25.60	$25.98
Predesign BW 2012	$34.05	$41.25	$25.60	$25.84

[a] As shown in Table 11, the 2005 rate process adopted a rate of $25.60 and a capacity charge of $34.05 with the intent of holding them stable for two and three years, respectively. These stable rates are held in both predesign scenarios.

[b] Levelized rates, without inflation 2004 $, provide a means of comparing two different series of rates that vary over time. If the indicated rate increases at the rate of inflation during the period it will yield the same revenue as the original, more variable, rate series.

The predesign estimates with a Brightwater on-line date of 2010 results in a capacity charge increase in 2008 of approximately $7.05 and adds approximately $.25 to the baseline sewer rate.

If the on-line date of Brightwater is moved to 2012, the increase in the 2008 capacity charge would be about $5.05 and add approximately $0.11 to the baseline sewer rate. Figure 7 presents the pattern of sewer rate changes over time with inflation, while Figure 8 presents the pattern with inflation removed. Figure 9 compares the capacity charge levels over time.

As mentioned above, these estimates can be expected to change as a result of changing economic conditions, refined estimates, and better information. For example, the timing of project expenditures will be refined and optimized and more will be known during the next RWSP 3-year update (2006) when it is time to renew the rate and capacity charge.

Figure 6
Comparison of Monthly Sewer Rate Projections (with Inflation)

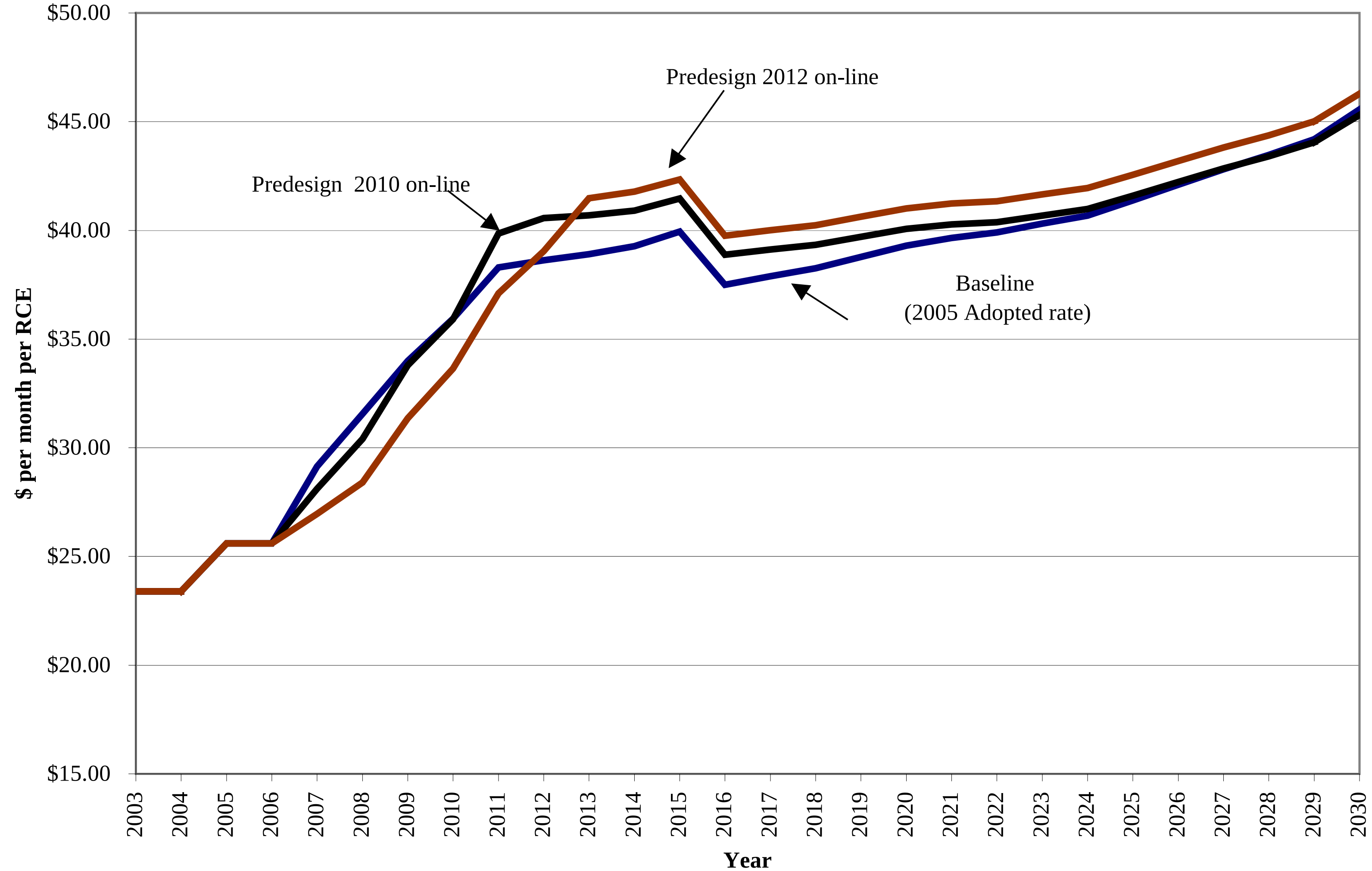


Figure 7
Comparison of Monthly Sewer Rate Projections (without Inflation – 2004 dollars)

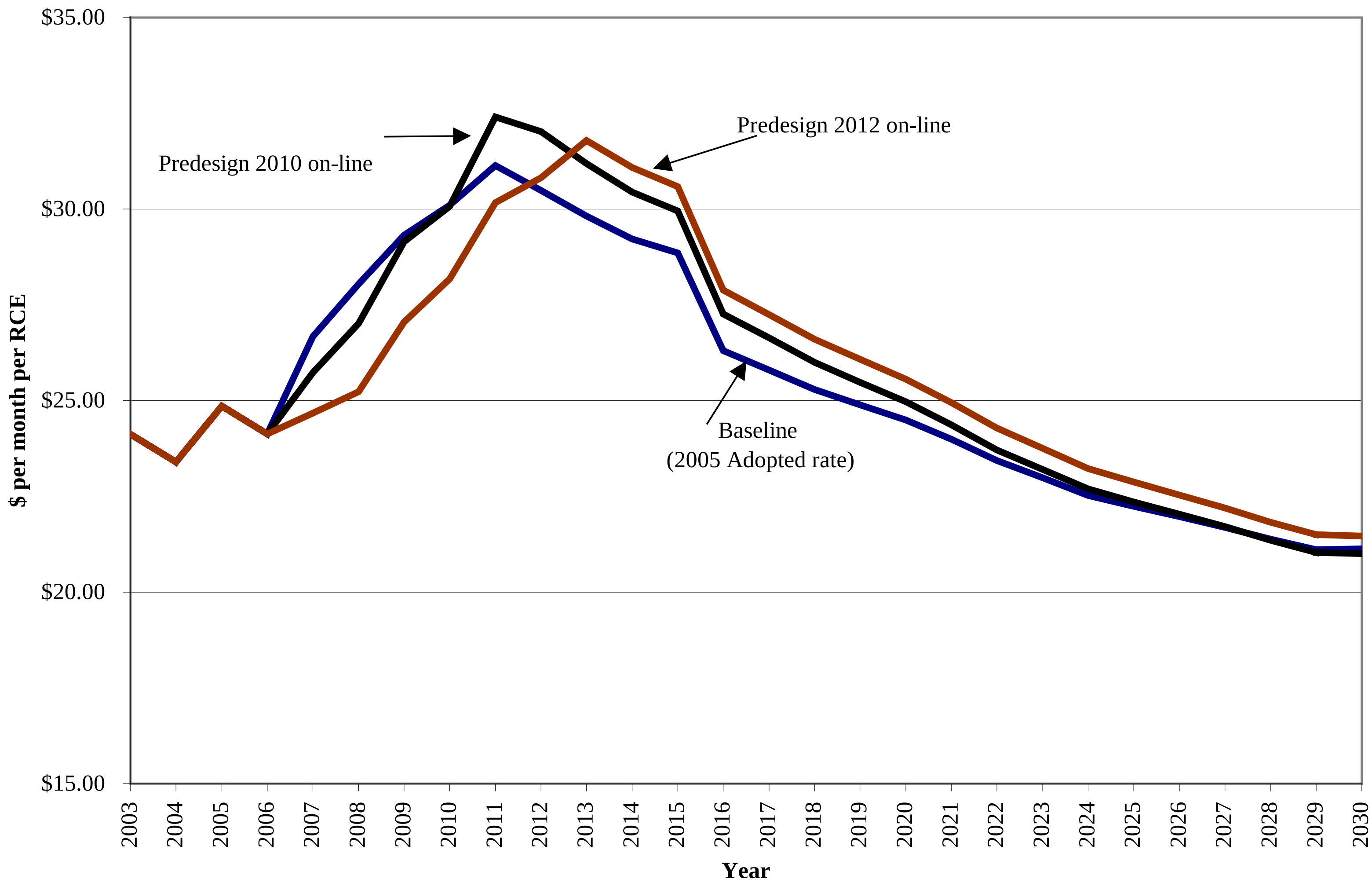
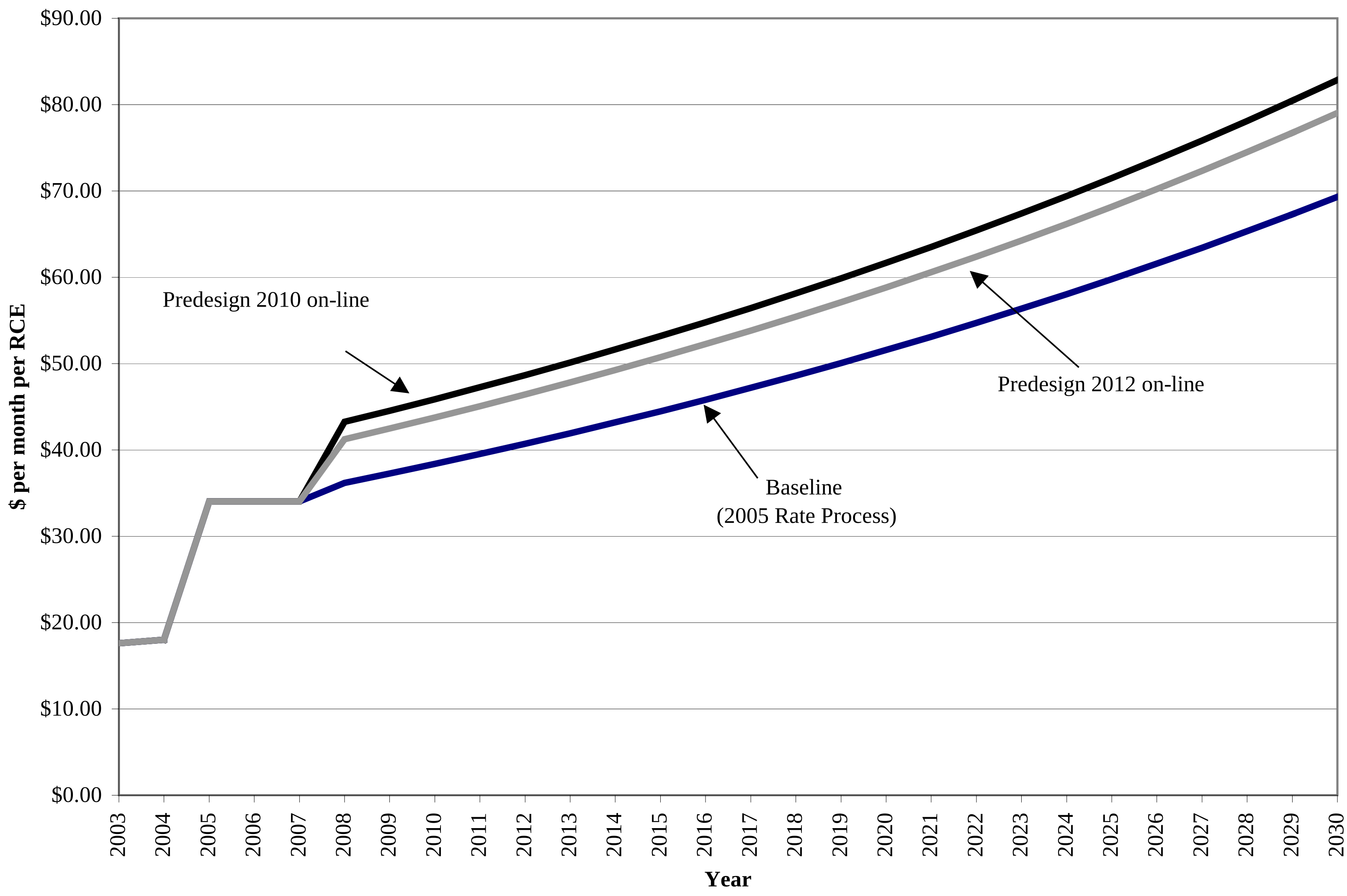


Figure 8
Monthly Capacity Charge Projections (with Inflation)



Attachment 1– Results of Value Engineering Process

Table 13

Treatment Plant Value Engineering Results

Item	VE Recommendation	Estimated Savings[a] (millions)	Design Team Recommendation	What Ended Up In Predesign	Revised Savings (millions)[a]	Comments
	Preliminary & Primary Treatment					
1	Reduce size of Headworks Building by about 15%	1.20	Accept	Fewer screens and other equipment; no change in building size	(2.60)	The estimated VE saving was offset by increases resulting from detailed estimating; design changes will support operation of this facility.
2	Use back-in loading for grit removal	0.30	Accept	Back-in loading	N/A	Included in Item 1
3	Use cyclone grit separators		Reject	Aerated grit (not vortex) in conjunction with CEPC; coanda units for grit separation instead of cyclones		Grit basins are much larger to allow time for CEPC floc formation; basin size may be reduced subject to CEPC pilot testing at South Plant. Coanda units will produce drier grit & reduce landfill costs.
4	Use chemically enhanced primary clarification (CEPC) only instead of combination of traditional primary and ballasted sedimentation	1.50	Accept	Design is for CEPC; will continue to refine based on pilot tests planned at South Plant in 2004/2005.	0.40	Tanks sized for reasonable overflow rates based on literature review; may reduce size or number of units based on pilot test results
5	Optimize tunnel storage and use to phase construction of primaries		Further Study	No storm flow peak shaving is recognized in design at this time	N/A	Will continue to evaluate and use if possible
	Biological Treatment					
6	Eliminate recycle stream of mixed liquor		Reject	Not in design; will not meet design criteria for effluent quality		Not process compatible
7	Store diurnal peaks; do not take diurnal peak flows through MBR	8.70	Accept	Design based on storing diurnal peaks; reduced number of MBR cassettes but not tankage; phased MBR equipment procurement	13.50	Savings was obtained through reducing the length of MBR tanks and phasing equipment purchase (initial MBR for 30 mgd flow)
8	Phase purchase of MBR equipment as flows increase	See comment	Accept	Partially implemented; will further refine procurement timing based on flows	N/A	Included in Item 7
	Solids Handling					
9	Delete overhead crane and reduce size of building	2.20	Accept	Reduced building size; removing crane was not cost effective	2.30	Predesign achieved more savings than projected by VE team
10	Reduce the size of the gravity belt thickener enclosure (reduces air treatment)	0.20	Accept	Size reduction accomplished & could result in unacceptable equipment repair times.	N/A	Included in Item 9
11	Optimize the volume of the sludge cake hoppers		Further Study	Not in design; savings proved to be minimal and could cause odor problems	N/A	Biosolids hoppers will allow for more efficient haul truck loading and will reduce the need to stage trucks onsite, which is a potential source of odor
12	Modify digesters	(0.80)	Reject	Rejected; did not meet operational requirements for redundancy and maintenance shutdowns		Digester modifications were tied to recommendations for modifications in primary treatment, which were not implemented
	Odor Control					
13	Reuse MBR exhaust air as process air (re-route foul air through tanks)	3.90	Accept	Reduced number of odor control trains by 2	1.10	Despite reductions in number of trains and air handled, costs decreased only slightly; reductions were offset by more hatch covers and longer duct runs because odor control was relocated to the west side of the process units
14	Combine redundant and maintenance odor control units to reduce total number	3.00	Accept	Reduced number of odor treatment trains by 1 and made other reductions in fans/ducting	N/A	Included in Item 13

Item	VE Recommendation	Estimated Savings[a] (millions)	Design Team Recommendation	What Ended Up In Predesign	Revised Savings (millions)[a]	Comments
15	Reduce ventilation rate to aeration and MBR units	See comment.	Accept	Less area being treated; savings captured in above items	N/A	Included in Item 13
	Water Reuse					
16	Build water treatment to initially serve only onsite needs	1.00	Accept	Design will accommodate onsite reuse needs	2.20	Will be incorporated into Brightwater reuse program
17	Phase off-site reuse lines/facilities as demand develops	0	Further Study		N/A	Will be incorporated into Brightwater reuse program
18	Build a water reuse filling station	0	Accept		N/A	Will be incorporated into Brightwater reuse program
	Power Generation					
19	Defer purchase and installation of standby power	7.40	Accept	Standby power is not included in the predesign	8.90	Substation facilities were taken out of the base Brightwater budget; will be included in the operating budget; cogeneration facilities deferred and carried as an “add back” item as design proceeds
	Non Process					
20	Cut size of admin. building by 15%	See comment	Accept	Currently evaluating options for housing admin and maintenance functions	4.60	StockPot Building is being considered as the least-cost option for admin., maintenance, and storage
21	Defer construction of storage building	0	Further Study	Stockpot Bldg. May be cost effectively used for storage	N/A	Included in Item 20
22	Defer heavy maintenance support facility	0	Further Study	Will continue to study required maintenance support and develop facilities according to base needs	N/A	Included in Item 20; heavy maintenance to be outsourced to other treatment plants; light maintenance could be housed in the StockPot Building
23	Eliminate chemical storage building; use covered areas as needed	1.60	Accept	Chemical building was reconfigured	5.80	Realized more savings than anticipated by VE
24	Reuse Opus and/or StockPot buildings for operations and/or storage	2.30	Accept	See Item 20	3.90	Included in Item 20
	Sitework					
25	Balance cut-and-fill quantities to reduce spoils disposal and contain contaminated soils	1.90	Accept	Optimizes cut-and-fill with the potential to eliminate most offsite disposal.	(1.90)	Screening landforms added to site stockpiling; additional site geotechnical work indicates the need for increased soil amendment for backfill and dewatering; estimates will be refined as more detailed information becomes available on earthmoving and construction sequencing
26	Phase implementation of stormwater system	0	Further Study	Will build necessary stormwater systems in initial phase	0.30	Increase in cost saving due to consolidated site plan
27	Relocate effluent collection box to north side of tunnel portal	0.20	Accept		3.40	Included savings in yard piping that are offset by increases noted below
28	Close-couple aeration basins and MBR to reduce length of gallery	1.30	Accept	Design shows significant decrease in total gallery lengths due to site compression; includes an influent flow vault	(4.50)	Galleries were initially estimated in the various facilities; this amount includes galleries for MBR, aeration basins, and primary treatment
	General VE Items			Items anticipated in Final EIS but not realized	(1.20)	
	Total Treatment Plant Construction Cost Savings	**35.90**			**36.20**	

[a] Numbers in parentheses indicate a cost increase.

Table 14

Conveyance System Value Engineering Results

Item	VE Recommendation	Estimated Savings (millions)	Design Team Recommendation	What Ended Up In Predesign	Revised Savings (millions)	Comments
1	Consider contracting strategy based on "pain-share/gain-share"	See comment	Consider	Current preferred approach is traditional design-bid-build.	N/A	Risks associated with alternative strategies outweighed benefits; geotechnical uncertainty as major concern
2	Set minimum shaft sizes and let contractor design	See comment	Accept	Design intent is to specify minimum size for shafts.	N/A	Saving anticipated, but cannot be quantified
3	Specify only required inside diameter (ID) of finished pipe in tunnels	See comment	Accept	Design intent is to specify minimum finished ID for tunnels	N/A	Saving anticipated, but cannot be quantified
4	Provide locations along route for planned tunnel boring machine (TBM) maintenance	See comment	Accept	Will develop idea and incorporate in specs as appropriate.	N/A	Will reduce risk of machine failure and associated costs/claims
5	Identify or develop a specific site for soils disposal	See comment	Accept	No project identified yet; will continue to explore	N/A	Could save on disposal costs if nearby sites are found
6	Require TBMs to have ground treatment capability	See comment	Accept	Will develop idea and incorporate in specs as appropriate.	N/A	Will reduce risk of ground loss if adverse conditions are encountered
7	Allow use of refurbished TBMs	See comment	Accept	Will develop idea and incorporate in specs as appropriate.	N/A	Has potential cost saving; must specify performance requirements
8	Maximize contractor selection of materials and methods	See comment	Accept	Will develop idea and incorporate in specs as appropriate.	N/A	Design team has been identifying alternatives as appropriate
9	Eliminate tunnel from portal 11 to 44 and replace with force mains	10.00	Further Study	Entire segment from Portal 11 to portal 44 was eliminated	10.00	Cost saving takes into account several other impacted components of the influent system; segment saving of $37 M was offset by increases in other areas
10	Influent Tunnel - Downsize portal 11 and move adjacent to pump station.	See comment	Further Study	Entire segment from Portal 11 to portal 44 was eliminated	N/A	Design team wanted to review impacts of street closure needed to move the portal
11	Size influent tunnels to optimize storage and treatment of peak flows.	See comment	Further Study	Influent segment from 44 to 41 was increased in size to provide more storage.	N/A	Final design will continue to analyze flows options for phasing and use of storage capacity
12	Pull minimum-sized effluent line inside tunnel and do not encase	1.60	Further Study	Due to concerns that interior pipe would float, idea was not implemented	N/A	Grout needed to fill tunnel is more expensive than original design
13	Use one-pass liner; test lining and repair leaks rather than install secondary liner	11.00	Further Study	Did not implement; stayed with two-pass liner where pressures are high	N/A	On more detailed study, reliability, access for inspection and repairs and aquifer protection were big concerns
14	Make combined tunnel 16' diameter and use fewer/smaller pipes.	12.00	Accept	Reduced tunnel diameter to 17'6" and eliminated one of the internal pipes	12.00	Will allow contractor option to further reduce tunnel size for additional savings
15	Consider separate shafts at Portal 41 for tunnel portal and IPS	Not calculated	Accept	Two separate shafts as recommended	N/A	Shaft size and shape are still being refined; savings will depend on final design configuration
	Total Conveyance Construction Cost Savings	**22.00**			**22.00**	

Table 15

Influent Pump Station Value Engineering Results

Item	VE Recommendation	Estimated Savings (millions)	Design Team Recommendation	What Ended Up In Predesign	Revised Savings (millions)	Comments
1	Delete one redundant utility feed	1.05	Further Study	Predesign eliminated one feeder as recommended	1.05	Result is one primary feed with generator backup
2	Use effluent for cooling generators	1.30	Further Study	Predesign stayed with air cooling	0	Concern about water supply led to keeping air cooling in design rather than water cooling
3	Reduce number of influent pipes (3 to 2)	N/A	Accept	Tunnel bore was reduced to 17'6" with 3 pipes.	N/A	VE team estimated savings at $7.6 million
4	Allow fill and draw pumping	0.06	Accept	Predesign allows for fill and draw pumping under some flow regimes	0	Does not change pumping needs significantly
5	Reduce number of cranes	0.32	Accept	Predesign deleted one crane from IPS building	0.04	Cost saving appears to be less than estimated by VE team
6	Minimize treated air volumes; reduce odor control in some areas	0.88	Further Study	Predesign building configuration changed and will require different odor control volume	0	Design will work to optimize air treatment and still meet KC odor control policies
7	Remove odor control bypass duct channels. Combine ducts in other channels.	0.04	Accept	Air ducts for odor control are designed in a common channel as recommended	0.04	Cost saving should be achieved
8	Separate the combined tunnel from IPS (do not have a separate excavation for tunnel)	0.55	Further Study	Revised layout eliminates separate shored area for tunnel as recommended by VE team	0	All underground structures and tunnel costs are now shown in conveyance costs (combined tunnel segment)
9	Reduce wet well length	2.70	Accept	The wet well dimensions are based on HI standards; ENSR will make a physical model during design	0	Any change, and resultant savings, will not be shown until modeling is done
10	Use round structures	Varies	Further Study	Predesign concept is round structure for influent structure and adjoining circles for the IPS	0	Cost savings are shown with combined tunnel segment; savings for IPS shaft is about $1.6 M
	Total IPS Construction Cost Savings	**6.90**			**1.13**	